Journal of Forensic and Legal Medicine 20 (2013) 777–784

Contents lists available at SciVerse ScienceDirect

Journal of Forensic and Legal Medicine

journal homepage: www.elsevier.com/locate/jflm

Original communication

Ethanol and drug findings in women consulting a Sexual Assault Center – Associations with clinical characteristics and suspicions of drug-facilitated sexual assault

Cecilie T. Hagemann, MD Consultant Gynecologist [a,b,*], Arne Helland, MD Consultant Pharmacologist [c], Olav Spigset, MD, PhD Consultant Pharmacologist, Professor [c,d], Ketil A. Espnes, MD Consultant Pharmacologist [c], Kari Ormstad, MD, PhD Professor of Forensic Medicine, Consultant Clinical Forensic Pathologist [e], Berit Schei, MD, PhD Professor of Women's Health, Consultant Gynecologist [a,b]

[a] Department of Public Health and General Practice, Norwegian University of Science and Technology, P.O. Box 8905, N-7491 Trondheim, Norway
[b] Department of Obstetrics and Gynecology, St. Olavs Hospital, Trondheim University Hospital, P.O. Box 3250, Sluppen, N-7006 Trondheim, Norway
[c] Department of Clinical Pharmacology, St. Olavs Hospital, Trondheim University Hospital, P.O. Box 3250, Sluppen, N-7006 Trondheim, Norway
[d] Department of Laboratory Medicine, Children's and Women's Health, Norwegian University of Science and Technology, P.O. Box 8905, N-7491 Trondheim, Norway
[e] Division of Forensic Medicine and Drug Abuse Research, Norwegian Institute of Public Health, P.O. Box 4404, Nydalen, N-0403 Oslo, Norway

ARTICLE INFO

Article history:
Received 18 October 2012
Received in revised form
17 April 2013
Accepted 31 May 2013
Available online 25 June 2013

Keywords:
Drug-facilitated sexual assault
Date rape drugs
Toxicological findings
Alcohol
Forensic service
Sexual assault center

ABSTRACT

The purpose of the study was to describe toxicological findings among women seeking health care after sexual assault, and to assess the relationship with so-called proactive DFSA (drug facilitated sexual assault). We also explored associations between ethanol in blood/urine and background data, assault characteristics, and clinical findings.

We conducted a retrospective, descriptive study of female patients ≥12 years of age consulting the Sexual Assault Center at St. Olavs University Hospital, Trondheim, Norway. They were examined between July 1, 2003 and December 31, 2010, and urine and/or blood were analyzed for ethanol and selected medicinal/recreational drugs.

Among the 264 patients included, ethanol and/or drugs were detected in 155 (59%). Of the 50 patients (19%) testing positive for drugs other than ethanol, benzodiazepines/benzodiazepine-like drugs were found in 31, central stimulants in 14, cannabinoids in 13 and opioids in nine. None tested positive for gamma-hydroxybutyrate (GHB). In total, 57 patients (22%) suspected proactive DFSA, but only five had findings of sedative drugs that were not accounted for by self-reported voluntary intake. No cases could unequivocally be attributed to proactive DFSA.

Among the 120 patients tested for ethanol within 12 h after the assault, 102 were positive. The median estimated blood alcohol concentration (BAC) at the time of assault was 1.87 g/L. Patients testing positive for ethanol more often reported a public place of assault and a stranger assailant. Higher estimated BAC at the time of assault was associated with higher frequency of suspecting proactive DFSA.

Ethanol was the most prevalent toxicological finding in urine/blood from victims of sexual assault, and high ethanol concentrations were often detected. Among the patients suspecting proactive DFSA, very few had sedative drug findings not explained by voluntary intake. It seems like opportunistic DFSA, rather than proactive DFSA dominate among the sexually assaulted attending our SAC.

* Corresponding author. Postal address: Department of Public Health and General Practice, Norwegian University of Science and Technology, P.O. Box 8905, N-7491 Trondheim, Norway. Tel.: +47 73 59 75 37 (Work), +47 958 29 490 (Mobile); fax: +47 73 59 75 77.
E-mail addresses: cecilie.hagemann@ntnu.no, cehag@online.no (C.T. Hagemann).

1752-928X/$ – see front matter © 2013 Elsevier Ltd and Faculty of Forensic and Legal Medicine. All rights reserved.
http://dx.doi.org/10.1016/j.jflm.2013.05.005

1. Introduction

During the last twenty years both the police and medical personnel have become more aware of drug-facilitated sexual assault (DFSA). The phenomenon can be divided into two categories[1]: i) Proactive DFSA or deliberate surreptitious drugging, i.e. covert administration of drugs to an unsuspecting victim, and ii) opportunistic DFSA, i.e. taking advantage of someone already inebriated by voluntary ingestion of sufficient amounts of drugs or alcohol to become intoxicated. In both cases, the potential victim has impaired consciousness and reduced ability to resist unwanted sexual advances.

Studies of DFSA typically emanate either from hospital records, police files or forensic toxicological laboratories. Recent studies based upon the first two categories report a high rate of self-reported voluntary ingestion of alcohol and/or drugs prior to the sexual assault[2–6] and that approximately one in five suspects proactive DFSA.[2,6] In contrast, studies from forensic toxicology laboratories report results on the basis of findings in urine/blood from cases of alleged DFSA.[7–14] These studies often have vaguely defined criteria for collecting samples, but presumably, the victim, the medical examiner and/or the police suspect some type of DFSA. Typical findings are high blood ethanol levels, while drugs commonly thought to be utilized in "date rapes" (e.g. flunitrazepam, gamma-hydroxybutyrate (GHB), ketamine) are rarely found. Laboratory studies often lack information about background variables and thus cannot differentiate cases of surreptitious drugging from cases of voluntary drug intake. However, a large British study combining laboratory data with information from police investigations found that less than two percent of the sedative drug findings could be attributed to proactive DFSA, whereas the vast majority of positive tests could be explained by voluntary intake.[8]

For more than two decades the Sexual Assault Center (SAC) at St. Olavs Hospital in Trondheim, Norway has offered medical assistance and forensic examination to sexual assaulted victims, irrespective of police reporting. After 2007 the SAC has collected urine and/or blood for drug analysis at the Department of Clinical Pharmacology at the same hospital from most consenting patients arriving within 3–4 days after the alleged assault.

Our aim was to describe the toxicological findings in an unselected population of patients seeking health care after a sexual assault, and to investigate whether the findings could be accounted for by voluntary intake or by surreptitious drugging. We also wanted to study associations between findings of ethanol/drugs in blood/urine and background data, assault characteristics and clinical findings.

2. Material and methods

2.1. Study design and settings

We conducted a retrospective, descriptive study of female patients ≥12 years of age who were examined at the SAC at St. Olavs Hospital, Norway, between July 1, 2003 and December 31, 2010. Our precinct is the county of Sør-Trøndelag, situated in central Norway, comprising about 280 000 inhabitants. The area includes the city of Trondheim, with about 160 000 inhabitants. The SAC's service is described in detail elsewhere.[15]

2.2. Participants

A total of 730 patients ≥12 years presented to the SAC during the study period. First, those of male sex ($n = 20$) or with no (suspected) sexual assault according to criteria stated in a Canadian study[2] ($n = 21$), and those in whom no medical examination was performed ($n = 68$), were excluded (Fig. 1).

The study was approved by the Regional Committee for Research Ethics. According to instructions from the committee, all patients eligible for inclusion received a letter with information about the study. Those who declined to participate on the basis of this letter ($n = 9$) were also excluded (Fig. 1). Finally, patients from whom no urine or blood had been obtained for toxicological analyses ($n = 348$) were excluded. Thus, in total, 264 patients were included in the study.

2.3. Data collection and variables

Information, including forensic reports and laboratory results, was extracted from the patients' records and registered through a web-based data collection system developed and administered by the Unit of Applied Clinical Research at the Norwegian University of Science and Technology.

Sociodemographic patient characteristics registered included age, country of origin (categorized as Western if in Western Europe, North America or Oceania; otherwise as non-Western), living situation (alone or with family/partner/other), residency (in the city of Trondheim or not), education, occupational status, and psychosocial history. The latter includes vulnerability factors as defined in a previous study,[16] except for the concept of mental health problems that included both a diagnosis of affective/psychotic illness, use of antidepressant/antipsychotic medication and history of use of mental health services, deliberate self-harm/attempted suicide and eating disorder.[17]

Self-reported voluntary intake of medicinal/recreational (non-prescribed) drugs was recorded from data provided at first SAC visit, at follow-up visits, or from recent relevant hospital records. Self-reported alcohol ingestion in relation to the assault was classified as no intake, intake of <5 units of alcohol, and intake of ≥5 units of alcohol. We used a definition of one alcohol unit corresponding to 12 g ethanol, which equals approximately one standard-sized glass of alcoholic beverage.[18]

A patient was classified as suspecting proactive DFSA when she herself addressed a suspicion of being involuntarily drugged and assaulted, in combination with at least one of 16 associated symptoms/signs (e.g. total or partial amnesia; "blackout", hangover or symptoms inconsistent with the amount of alcohol or drugs voluntarily ingested).[2]

Assailant characteristics like assumed age, country of origin and number of assailants were recorded. Factors such as location of assault and relationship between patient and assailant were defined as in a previous paper.[15] Time of the day of the assault was dichotomized to 7 a.m. to midnight or midnight to 7 a.m.

Physical violence was graded as "severe" (presence of weapon, attempted strangulation, gagging, punching or kicking toward head), "light/moderate" (holding, tearing off clothes, slapping, kicking, tying up, biting, sucking, stinging with needle), or "none/verbal threats". The assault was classified as penetrative when the patient reported vaginal and/or anal penetration by foreign object, as well as when the patient reported vaginal and/or anal and/or oral penetration by penis. When the patient reported vaginal and/or anal penetration by finger, as well as other sexual acts than already mentioned, we recorded the assault as non-penetrative. The sexual act was classified as "no recollection" if the incident had occurred while the patient was asleep, heavily inebriated or unconscious.

Objective documentation upon the SAC visit included emotional status, perceived degree of inebriation, and observed extragenital and anogenital injuries. Extragenital injuries were classified as serious, moderate or minor according to a previous study.[15] Anogenital injuries included tears, abrasions and bruises (ecchymoses/

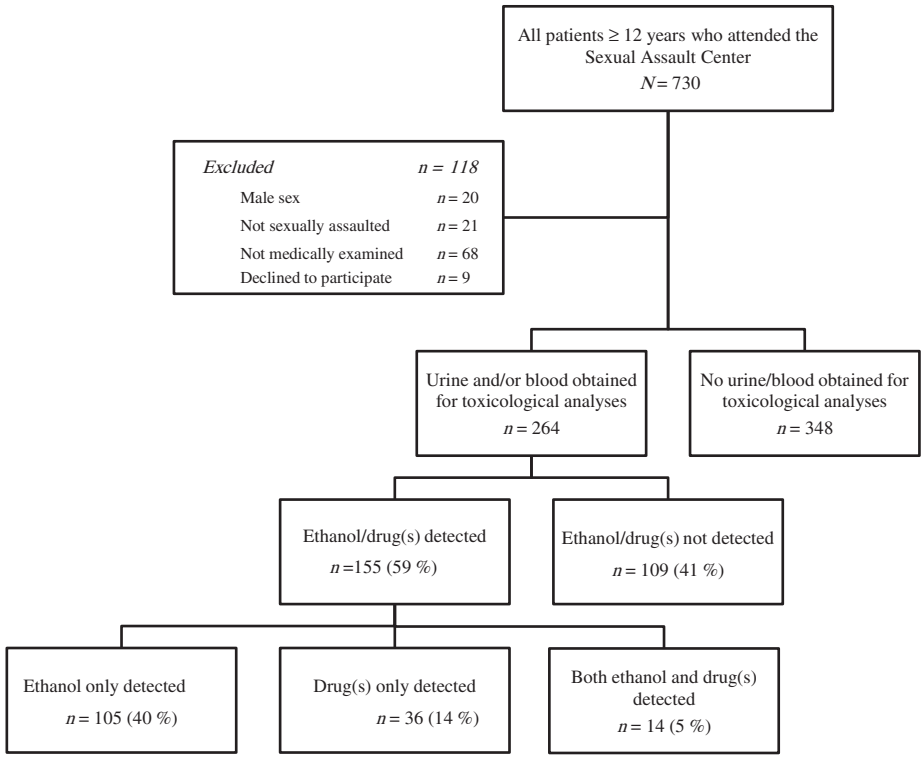

Fig. 1. Flow diagram showing the inclusion of subjects in the study and the toxicological findings of the 264 female patients finally included in the study.

petechiae); redness and/or swelling was not regarded as an injury.[15,19,20]

The event was recorded as police-reported if the patient said so or if the police requested a medico-legal report for investigational use.

The time point for toxicological sampling was recorded; if not specifically stated, the sampling was assumed to have taken place one hour after arrival at the SAC. To estimate the time interval between the assault and the toxicological sampling, we used the mid-point of the time period for the assault.[7]

The blood alcohol concentration (BAC) was estimated from the measured serum ethanol concentration using a serum-to-blood ratio of 1.14. If the serum sample was missing, but the ethanol concentration in urine was known, a mean elimination phase urine-to-blood ratio of 1.345 was used to estimate BAC.[21] To estimate the BAC at the time of assault, concentrations were back-calculated assuming no ethanol intake after the assault and a metabolic rate of 0.15 g/L ethanol per hour.[14]

2.4. Toxicological examination and analysis

Urine and/or blood specimens were analyzed at the Department of Clinical Pharmacology, St. Olavs Hospital. If available, urine samples were screened for a predefined selection of substances likely to be used in DFSAs,[22] and included ethanol and the drug classes benzodiazepines/benzodiazepine-like drugs, cannabinoids, opioids, central stimulants and some others, including GHB and ketamine (see Supplementary Table 1 for details about the analytes determined by the different methods and their limits of detection). If the urinary screening test was positive for one or more of these substances, the corresponding substances were also quantified in serum. If the screening was negative, the serum sample was discarded. In cases with only serum available, a general drug screening was not possible due to the relatively low serum volumes obtained. In these cases, specific analyses in serum were prioritized according to the characteristics of the individual case.

The analytical methods employed were liquid chromatography/mass spectrometry (LC/MS), gas chromatography/mass spectrometry (GC/MS) and immunoassay. For the LC/MS analysis, the samples were extracted under alkaline conditions and neutral/acidic conditions with liquid–liquid extraction. The concentrated extracts were then analyzed on Agilent 1100 MSD single quadrupole instruments (Agilent, Palo Alto, CA), applying both electrospray and chemical ionization. Analytes were separated on a Zorbax C18 column (30 × 4.6 mm, 3 μm particle size; Agilent, Palo Alto, CA) using formic acid/ammonium acetate buffer and methanol as the mobile phase. Deuterated internal standards were used. The inter-day coefficients of variation were generally less than 10%.

Urine was screened for GHB and ethanol by GC/MS on an Agilent 7359 single quadrupole mass spectrometer (Agilent, Palo Alto, CA), and for Lysergic acid diethylamide (LSD) and barbiturates by an immunoassay method on a Cobas Integra 400 analyzer (Roche AG, Basel, Switzerland). From 2009, ethanol analyses were performed by this immunoassay method as well.

2.5. Statistical analysis

Variables were analyzed by descriptive statistics, and the associations between the outcome variable and the independent categorical variables were analyzed. Data analysis was performed with the statistical program package SPSS version 19.0. For continuous variables we used Student's *t*-test. For categorical variables Pearson's χ^2 test, exact unconditional test or Pearson's χ^2 test of heterogeneity were used as appropriate. Kruskal–Wallis non-parametric test were used for some ordinal data with small sample size. Statistical significance was assumed when $p < 0.05$. In some analyses, multivariable logistic regression was applied to adjust for patients' age and time interval from assault to toxicological sampling.

3. Results

3.1. Study population

Of the 264 eligible patients, toxicological analyses were performed in both blood and urine in 206 cases, in urine only in 41 cases and in blood only in 17 cases. Altogether, 184 of the patients (70%) were included during the period 2008–2010.

Background characteristics of the 264 patients are shown in Table 1. Median age of the patients was 21 years (mean 24 years, range 12–61 years). A suspicion of proactive DFSA was stated by 57 patients (22%) and a voluntary intake of alcohol by 222 (84%). Voluntary intake of medications/drugs other than alcohol was reported by 76 patients (29%) (range 1–6 drugs), and only 22 (8%) reported no intake of either alcohol or drugs. Altogether 117 patients (44%) had a history of mental health problems and 35 (13%) reported alcohol/drug abuse.

3.2. Characteristics of the assault and clinical findings

Assault and assailant characteristics are shown in Supplementary Table 2. A penetrative assault was reported by 142 patients (55%), while 97 (37%) had no recollection of the sexual acts. In total, 154 cases (64%) were reported to the police.

The median time interval from assault to urine/blood sample collection was 12.5 h (mean 29.6 h, range one hour to 16 days). In total, 128 (48%) arrived at the SAC within 12 h and 238 (90%) within 72 h.

3.3. Findings of ethanol and drugs in urine and blood

Fig. 1 and Table 2 show findings of ethanol and drugs in urine and/or blood specimens.

A total of 50 patients (19%) tested positive for at least one drug other than ethanol in urine and/or blood; one substance was detected in 31, while two or more substances were detected in 19 patients. For drugs other than ethanol, the time from assault to sampling did not influence the rate of positive tests.

Table 3 gives an overview of the drugs other than ethanol found in serum and/or urine and the range of concentrations in the serum samples. None tested positive for GHB or Ketamine. The 154 police-reported cases did not differ from the total material of cases with regard to the distribution of positive tests.

3.4. Patients suspecting proactive DFSA

Among the 57 patients suspecting proactive DFSA, 22 tested negative, 22 were positive for ethanol only, while 13 were positive for at least one drug other than ethanol (eight positive for drug only, five positive for both ethanol and drug). The frequency of positive findings was similar for the group of patients not suspecting proactive DFSA. The number of positive cases for each drug group among the 13 drug positive patients suspecting proactive DFSA is shown in Table 3, right column. Among these, seven patients had drug findings that could not be explained by self-reported voluntary intake; five were positive for benzodiazepines (one for clonazepam, four for diazepam and/or oxazepam), one was positive for opioids (morphine and oxycodone), two were positive for cannabis, and four were positive for amphetamines (some tested positive for more than one drug). In addition, two patients had unexpectedly high concentrations of the drugs they had voluntarily ingested; one case with flunitrazepam and one case with zopiclone.

Among the 57 patients suspecting proactive DFSA, only three did not report intake of alcohol/drug(s), while 36 reported intake of alcohol only, 17 reported intake of alcohol and drug(s) and one reported intake of drug(s) only. The proportions were similar to those in the group not suspecting proactive DFSA ($X^2 = 6.8$, $df = 3$, $p = 0.080$).

Table 1
Background characteristics of 264 female patients attending the Sexual Assault Center between July 1, 2003 and December 31, 2010 who were tested for alcohol/drugs in urine and/or blood.

Characteristics	Number (%)
Patient age, $n = 264$	
12–17 years	57 (22)
18–24 years	137 (52)
≥25 years	70 (27)
Country of origin, $n = 262$	
Norwegian/Western	252 (96)
Non-western	10 (4)
Living situation, $n = 259$	
Alone	124 (48)
With family/partner/other	135 (52)
Residency, $n = 263$	
City of Trondheim	166 (63)
Outside Trondheim	97 (37)
Education, $n = 184$	
≤ 13 years	124 (67)
>13 years	60 (33)
Occupation, $n = 255$	
Student	128 (50)
Employed	65 (25)
Unemployed	62 (24)
Vulnerability factors, $n = 264$[a]	
No vulnerability factor	95 (36)
Physical or cognitive disability	25 (9)
History of alcohol/drug abuse	35 (13)
History of mental health problems	117 (44)
Previous sexual assault(s)	105 (40)
Alcohol consumption, $n = 257$	
No intake	35 (14)
Intake of <5 units	50 (19)
Intake of ≥5 units	172 (67)
Voluntary intake of other medications/drugs, $n = 264$[a]	
Benzodiazepines and/or benzodiazepine-like drugs	23 (9)
Cannabinoids	9 (3)
Opioids	5 (2)
Central stimulants	14 (5)
Other medications	51 (19)
No intake/missing[b]	188 (71)
Suspected proactive drug-facilitated sexual assault, $n = 263$	
No	195 (74)
Yes	57 (22)
Uncertain information	11 (4)

[a] More than one category were reported by a number of patients.
[b] Uncertain number of cases with missing information vs. no intake of medications/drugs other than alcohol.

Table 2
Overview of drugs found in blood and/or urine from 264 female patients attending the Sexual Assault Center between July 1, 2003 and December 31, 2010.

Substance or substance combinations	Number (%)
Ethanol only	105 (40)
Benzodiazepines only	13 (4.9)
Other central depressants only[a]	7 (2.7)
Ethanol + benzodiazepines	9 (3.4)
Ethanol + other central depressants[b]	4 (1.5)
Benzodiazepines + opioids	3 (1.1)
Central stimulants, with or without other drugs[c]	14 (5.3)
Negative toxicological test	109 (41)
Total	264 (100)

[a] Cannabis ($n = 6$), opioids ($n = 1$).
[b] Cannabis ($n = 2$), opioids ($n = 1$), cannabis + opioid ($n = 1$).
[c] Central stimulants (CS) only ($n = 5$), CS + benzodiazepines ($n = 3$), CS + cannabis ($n = 2$), CS + benzodiazepines/opioids/cannabis ($n = 2$), CS + benzodiazepines/opioids ($n = 1$), CS + ethanol ($n = 1$).

Table 3
Overview of drugs other than ethanol found in serum and/or urine, range of concentrations determined in serum, self-reported voluntary intake and the number of cases suspecting proactive drug-facilitated sexual assault (DFSA). The results are based upon 50 positive tests from a total of 264 female patients attending the Sexual Assault Center between July 1, 2003 and December 31, 2010.

Substance	Urine and/or serum positive, *n*	Range of serum concentrations (ng/mL)	Self-reported intake, *n* among positive	Suspecting proactive DFSA[a], *n* among positive
Benzodiazepines and/or benzodiazepine-like drugs	31/256 (12%)		21/31	8/31
Alprazolam	1/253 (0.4%)	15	1/1	0/1
Clonazepam	8/253 (3.2%)	9–152	7/8	2/8
Diazepam/desmethyldiazepam	8/254 (3.1%)	40–2300	2/8	3/8
Flunitrazepam	2/255 (0.8%)	6[b]	1/2	1/2
Nitrazepam	2/254 (0.8%)	60[c]	1/2	1/2
Oxazepam	18/254 (7.1%)	6–2276	10/18	5/18
Zolpidem	1/187 (0.5%)	93	1/1	0/1
Zopiclone	5/227 (2.2%)	9–100	3/5	1/5
Meprobamate	1/220 (0.5%)	327	0/1	0/1
Cannabinoids	13/239 (5.4%)		4/13	2/13
Cannabis (THC)	13/239 (5.4%)	0.50–6.10	4/13	2/13
Opioids	9/251 (3.6%)		4/9	1/9
Codeine	6/250 (2.4%)	3–494	4/6	0/6
Methadone	1/231 (0.4%)		1/1	0/1
Morphine[d]	5/250 (2.0%)	0.05–50[e]	4/5	1/5
Oxycodone	2/216 (0.9%)	16[f]	0/2	1/2
Central stimulants	14/244 (5.7%)		7/14	8/14
Amphetamine	9/244 (3.7%)	40–353	3/9	6/9
Methamphetamine	7/244 (2.9%)	8–270	4/7	5/7
Methylphenidate	4/185 (2.2%)		3/4	1/4
Total	50/264 (19%)		33/50	13/50

[a] Includes some cases admitting voluntary intake, see text for details.
[b] Both positive cases had the same concentration in serum.
[c] Only one of the two serum samples was analyzed for nitrazepam.
[d] Including the metabolites morphine 3-glucuronide and morphine 6-glucuronide.
[e] Range of serum concentration for morphine only.
[f] Only one of the two tested positive in serum.

3.5. Ethanol positive cases

In a subsample of 120 patients tested for ethanol within 12 h after the assault, 102 (85%) were positive. Among these, median time from assault to toxicological sampling was 4.4 h (mean 5.1 h, range 1.0–11.8 h).

Some of the clinical characteristics of those testing positive and negative for ethanol, respectively, are presented in Table 4. Patients testing positive for ethanol more often reported a public place of assault, a stranger assailant and more than one assailant. Patients who tested negative for ethanol more often reported vulnerability factors.

We found no differences between the two groups regarding patient age, other background characteristics, suspicion of proactive DFSA or reporting the event to the police. Adjusting for patients' age and interval from assault to toxicological sampling did not alter any of the relations stated above.

Estimated median BAC at the time of sampling was 1.20 g/L (mean 1.19 g/L, range 0.20–2.80 g/L). Back-calculation based upon the 102 ethanol positive samples resulted in a median estimated BAC at the time of assault of 1.87 g/L (mean 1.92 g/L, range 0.44–3.95 g/L).

There was a positive relationship between estimated BAC at the time of assault and patient age ($t = 3.14$, $p = 0.002$), but not with assailant age ($t = 1.24$, $p = 0.22$).

The population of patients tested for ethanol within 12 h after the assault was divided in tertiles on the basis of estimated BAC at the time of assault. There were significant associations between increasing BAC levels and reported intake of five or more alcohol units ($X^2 = 13.7$, $df = 2$, $p = 0.001$), suspicion of proactive DFSA ($X^2 = 7.2$, $df = 2$, $p = 0.027$), the assailant being a stranger ($X^2 = 12.3$, $df = 2$, $p = 0.002$), and a clinical impression of inebriation on examination ($X^2 = 21.6$, $df = 2$, $p < 0.001$).

4. Discussion

The principal findings in the present study are that among the 264 patients included, 155 (59%) tested positive for ethanol and/or drugs; 105 (40%) for ethanol only and 50 (19%) for one or more drugs other than ethanol. In total, 57 patients (22%) suspected proactive DFSA, but only five had findings of sedative drugs that could not be explained by self-reported voluntary intake. No case could unequivocally be attributed to proactive DFSA. Finally, patients testing positive for ethanol more often reported a public place of assault and a stranger assailant, and the higher estimated BAC at the time of the assault, the higher the frequency of suspecting proactive DFSA.

The finding that 59% tested positive for ethanol and/or drugs is in accordance with the results from police-initiated studies in the USA, the UK, Sweden and the Netherlands, with percentages varying between 61 and 73.[8,11,13,23] A SAC-based study from Canada found a prevalence of positive tests of 76%.[24] Although the numbers are relatively homogenous between studies, inclusion criteria for the collection of samples varied widely, from including all sexual crimes irrespective of any claims of DFSA,[23] via including only those who "believed that drugs were involved",[11,12] to including cases with a suspicion of proactive DFSA only.[8,9,13,24] In the present study, there were minimal differences in the prevalence of alcohol/drugs between police-reporting patients and the total group of patients attending the SAC.

In our study, 19% of the patients tested positive for one or more drugs other than ethanol, similar to findings in other Scandinavian studies,[23,25,26] but lower than in studies conducted in other parts of the Western world.[8,13,24] This probably reflects the relatively low prevalence of recreational drug use in Scandinavia as compared to other Western countries.[27–29] Discrepancies between studies may in part be due to differing selection of analyzed substances.[8,11,13,14,24]

Table 4
Background and assault characteristics and clinical findings by ethanol results among 120 female patients attending the Sexual Assault Center between July 1, 2003 and December 31, 2010 who were tested for ethanol in urine and/or serum within 12 h after the assault.

Variable	Ethanol positive, $n = 102$, n (%)	Ethanol negative, $n = 18$, n (%)	p
Background characteristics			
Patient age, $n = 120$			
12–17 years	15 (15)	4 (22)	
18–24 years	64 (63)	7 (39)	
≥25 years	23 (23)	7 (39)	0.16[a]
Vulnerability factors, $n = 120$			
Yes	66 (65)	17 (94)	
No	36 (35)	1 (6)	0.012[b]
Alcohol consumption, $n = 118$			
No intake	0	10 (59)	
Intake of <5 units	21 (21)	4 (24)	
Intake of ≥5 units	80 (79)	3 (18)	0.0001[a]
Suspected proactive drug-facilitated sexual assault, $n = 115$			
Yes	22 (23)	2 (11)	
No	75 (77)	16 (89)	0.29[c]
Occupation, $n = 118$			
Employed/student	77 (76)	11 (65)	
Unemployed	24 (24)	6 (35)	0.38[c]
Assault reported to the police, $n = 111$			
Yes	65 (68)	10 (63)	
No	30 (32)	6 (38)	0.64[b]
Assault characteristics			
Type of sexual assault, $n = 116$			
Penetration	56 (57)	13 (77)	
No penetration/other acts	8 (8)	1 (6)	
No recollection	35 (35)	3 (18)	0.75[c,d]
Physical violence, $n = 86$			
Yes	52 (73)	13 (87)	
No/verbal	19 (27)	2 (13)	0.32[c]
Location of assault, $n = 110$			
Private	53 (57)	15 (88)	
Public	40 (43)	2 (12)	0.015[b]
Victim/assailant relationship, $n = 106$			
Known	63 (70)	16 (100)	
Stranger	27 (30)	0	0.011[c]
More than one assailant, $n = 109$			
Yes	19 (20)	0	
No	74 (80)	16 (100)	0.048[c]
Assailant origin, $n = 91$			
Western	55 (72)	13 (87)	
Non-western	21 (28)	2 (13)	0.27[c]
Time of day of assault, $n = 120$			
7 a.m. – midnight	20 (20)	12 (67)	
Midnight – 7 a.m.	82 (80)	6 (33)	0.0002[c]
Clinical findings			
Clinically intoxicated, $n = 116$			
Yes	68 (69)	2 (12)	
No	31 (31)	15 (88)	0.0001[b]
Extragenital injury, $n = 114$			
Yes	62 (65)	9 (50)	
No	34 (35)	9 (50)	0.24[b]
Anogenital injury, $n = 108$			
Yes	28 (31)	5 (29)	
No	63 (69)	12 (71)	0.95[c]

[a] Kruskal Wallis test, $df = 2$.
[b] Chi-square test, $df = 1$.
[c] Exact unconditional test.
[d] Given p-value for penetration vs. no penetration/other acts by alcohol, $n = 78$.

In addition, some studies include blood tests only, thereby narrowing the time window for the detection of substances and decreasing the number of positive tests compared to urinary testing.[25] We analyzed both urine and blood (serum) when available, and included a considerable number of medicinal and recreational drugs, i.a. those known or suspected being used in DFSA.[22] We did not include antidepressants, antipsychotics, sedating antihistamines or other, non-sedative, therapeutic drugs. However, as these drugs are less likely to be involved in DFSA and would rather be expected to be used therapeutically in these populations, we argue that it is more appropriate to exclude such drugs than to include them.

We found central stimulants in 6% of the patients, whereas cannabinoids were detected in 5%. Central stimulants are probably of low relevance in cases of proactive DFSA as they do not have sedative effects, and a positive test for cannabinoids in urine does not necessarily indicate a recent intake, as the detection window can be several weeks.

Benzodiazepines and related agents (zopiclone, zolpidem) are probably more relevant in proactive DFSA, and their sedative and amnesic effects may be augmented by ethanol. We found that benzodiazepines and related agents formed the most prevalent drug group with a frequency of 12%; a proportion that is equivalent to what have been found by others,[8,12,13,23,25] but far less than the 82% reported among more selected cases of alleged chemical submission (of which 50% were proactive DFSAs) from France.[30] In two thirds of our cases positive for benzodiazepines and related agents, patients reported voluntary intake of the drug.

We found opioids in 4%, mainly the weak opioid codeine and its metabolite morphine. Although codeine is sedating, it is widely used as a painkiller in Norway, indicating that this drug could have been ingested as an analgesic also after the assault.

In many cases, there was a relatively long time interval from the assault until the sample was obtained. In these cases, we may have been unable to detect intake of short-acting drugs, such as GHB. In other DFSA case series from the last ten years, less than 2% of the tests have been positive for GHB,[8,13,14,24] but also in these studies the time intervals from assault to sampling varied considerably. Thus, the true prevalence of GHB intake in cases of sexual assault is basically unknown.

As many as 22% of the patients suspected proactive DFSA; a relatively large increase from 7% in the early nineties and 17% some ten years ago at our SAC.[31,32] Such an increase was also seen in Canada during the nineties, up to 23% in 1999.[33] This pattern most likely reflects a growing awareness of the phenomenon, e.g. promoted by coverage in media. Other studies from Western SACs report rates of suspected proactive DFSA ranging from 3% in France[34] via 12% in Denmark[25] to 21% in a recent study from Canada.[2] In an Australian study, 18% of the cases were defined as suspected proactive DFSA by the authors, but only 5% of the victims themselves addressed this suspicion.[6] Inhomogeneous inclusion criteria make a direct comparison difficult. We chose to use the relatively strict definition of (self-reported) proactive DFSA as recommended in the recent Canadian study.[2]

In two patients suspecting proactive DFSA, one reporting voluntary intake of flunitrazepam, and the other reporting voluntary intake of zopiclone, the blood drug concentrations were unexpectedly high. Both had combined intakes of alcohol and drugs, and reported periods of memory loss. In theory, a woman may be subjected to proactive DFSA with a substance also used voluntarily, although this seems rather unlikely. As we could not exclude voluntary drug intake after the assault, we conclude that the suspicion of proactive DFSA could not be substantiated in these two cases.

Among those suspecting proactive DFSA, sedative drugs (clonazepam, diazepam and/or oxazepam) not reported being taken voluntarily were detected in five. These patients either gave a history of alcohol/drug abuse or anxiety disorder, making recent voluntary intake of one or more of these drugs likely. We thus have concluded that none of the cases could unequivocally be attributed to proactive DFSA.

The frequency of verified proactive DFSA is low also in other studies. In a large British case series[8] the authors concluded that

only 2% of more than 1000 cases could be attributed to proactive DFSA. A recent Danish study found that among 20 patients suspecting proactive DFSA, four had a positive blood test for one or more sedative drugs not reported to be taken voluntarily.[25] Relatively high proportions of unexpected drugs were found in studies from Australia and Canada; 49% and 20%, respectively.[6,24] However, the ascertainment of the self-reporting of voluntary intake in these studies is unclear, and it has been claimed that self-reported intake of drugs is unreliable.[35] In the present study, we have tried to refine the methodology by asking the patients a second time after a positive toxicological finding whether they nevertheless might have ingested the drug voluntarily, although they did not mention that intake at the first visit.

We found a high rate (86%) of self-reported intake of alcohol, whereas slightly less than half of all patients tested positive for ethanol. This finding is comparable to the results from other studies.[6,7,9,11,13,14,24,25] The discrepancy between self-reported alcohol intake and analytical findings could be explained by the short detection time of ethanol in biological samples. When we restricted the sample to patients arriving within 12 h of the assault, 85% of the patients tested positive, which is in good accordance with the rate of self-reported intake. Urine markers of alcohol intake with longer detection times, such as ethyl glucuronide and ethyl sulfate, have been shown to be more suitable than ethanol to confirm alcohol intake when the time span from assault to sampling exceeds 12 h,[36] and should be further explored among female sexual assault victims.

We estimated a median BAC at the time of assault to 1.87 g/L. Such back-calculations are inaccurate, both because the metabolic rate of ethanol is subjected to substantial inter-individual variability and because the time of the assault may be inaccurately reported and does not always coincide with cessation of alcohol intake.[14] Even when taking these limitations into account, we consider that back-calculation gives a reasonable impression of the actual BAC levels that could occur in conjunction with sexual assaults. The result is in accordance with findings from other studies,[6,7,9,13,14] and is consistent with the fact that 77% of the women who ingested alcohol in the current study admitted to drinking more than five units. It is also well established that females have a lower body water content than males and hence will achieve a higher blood ethanol concentration after equal intake.

A high estimated BAC at the time of assault was associated with more frequent suspicions of proactive DFSA. In a study from Canada, a higher proportion reported alcohol intake among those suspecting proactive DFSA.[2] Although it is possible that drinks could have been spiked with alcohol by others, self-reported intake of alcohol is in many cases considerable, indicating that the women may have underestimated the effect of voluntary alcohol consumption, and rather tend to suspect proactive DFSA.

A striking finding was that ethanol positive patients more often reported being assaulted by a stranger. The police in the capital Oslo has shown that more than half of those reporting stranger rapes were under the influence of alcohol.[3] In a SAC-based study from Sweden, alcohol intake was also more common in cases where the assailant was a stranger or an acquaintance, in contrast to an intimate partner.[37] It is reasonable to believe that women with reduced consciousness and impaired ability to identify potentially risky situations due to excessive alcohol intake may more easily be selected as victims at public places by would-be stranger assailants.

In addition to the strengths and weaknesses already discussed, some more general issues should be addressed. One of the strengths is the close access to clinical variables and medical records, making it possible to study associations and relationships in detail. The design enabled us directly to compare self-reported intake of alcohol and drugs with toxicological findings and to characterize differences between ethanol positive and negative cases for an array of variables.

As the present study represents an unselected female population attending a SAC, it would reflect the “true” prevalence of alcohol/drug findings among this group of patients, at least in the catchment area studied. However, many victims of sexual assault do not seek medical care, and our results are therefore not necessarily applicable to victims of sexual assault in general. Moreover, generalization of our findings to other countries should be done with caution. Both the populations subjected to sexual assault and those seeking help may differ considerably between countries, and the indications for performing a toxicological test may vary.

Data on voluntary drug intake may be incomplete, especially for drugs with long detection times which may have been ingested several days before the assault. Although we presented the toxicological test result to the patients at a follow-up visit, they may still hesitate to admit use of illicit or non-prescribed drugs, e.g. in case of a police investigation. Due to a fear of being blamed for illegal drug use, the patient might have found it safer to report that the drug was covertly administered to her. In our SAC, however, the results of urine and/or blood tests collected for the purpose of detection of surreptitious drugging cannot be used to initiate any legal sanctions against her. Still, there is always a possibility that information about the assault given solely by the victim (or her companions) may be incomplete, false or exaggerated.[16]

Our study is also limited by a relatively small sample size, especially concerning cases of suspected proactive DFSA. Comparisons between ethanol positive and ethanol negative cases may have been subjected to type 2 statistical errors, and comparisons between drug positive and drug negative cases were not possible due to the lack of power. Even so, most other studies containing information on voluntary drug consumption have included even fewer subjects.[1,6,24,25,35]

5. Conclusion

Ethanol, often in high concentrations, as well as sedative drugs or drugs of abuse were frequently detected in samples collected from victims of sexual assault. As very few of the patients suspecting proactive DFSA had findings of sedative drugs not explained by voluntary intake, it seems that opportunistic DFSA rather than proactive DFSA dominate in our material.

We believe that victims of sexual assault should have easy and fast access to emergency health care with a trained staff, and should be encouraged to seek immediate help. Toxicological screening should be routinely offered to achieve a comprehensive assessment in each individual case. Based on the current study, it should be communicated that the perceived danger of surreptitious drugging with so-called “date rape drugs” such as GHB and flunitrazepam is most likely overrated, whereas the dangers of voluntary excessive intake of alcohol (and drugs) should be emphasized more.

As population data indicate that sexual assailants are influenced by alcohol/drugs even more often than the victims,[38] we suggest that future research should explore alcohol and drug findings among the assailants in a police setting.

Conflict of interest

None of the authors have any conflict of interest by publishing this article.

Funding

Cecilie Therese Hagemann received funding from the Norwegian Extra Foundation for Health and Rehabilitation through The Norwegian Women's Public Health Association, as well as from the Liaison Committee between the Central Norway Regional Health

Authority (Helse Midt-Norge) and the Norwegian University of Science and Technology. The work of the other authors was carried out solely with institutional funding.

The role of the funding sources

The funding sources have no involvement in the study design, data collection, data analysis and interpretation, in writing of manuscript or the decision to submit, except for approving the initial and revised study protocols.

Ethical approval

None declared.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jflm.2013.05.005.

References

1. Gee D, Owen P, McLean I, Brentnall K, Thundercloud C. *Operation MATISSE: investigating drug facilitated sexual assault*. London: The Association of Chief Police Officers (ACPO); 2006.
2. Du Mont J, Macdonald S, Rotbard N, Asllani E, Bainbridge D, Cohen MM. Factors associated with suspected drug-facilitated sexual assault. *Can Med Assoc J* 2009;**180**:513–9.
3. Sætre M, Grytdal V. *Voldtekt i den globale byen – Endringer i anmeldte voldtekter og Seksualkultur i Oslo*. Oslo: Strategisk stab, Oslo Politidistrikt; 2011.
4. Gisladottir A, Gudmundsdottir B, Gudmundsdottir R, Jonsdottir E, Gudjonsdottir GR, Kristjansson M, et al. Increased attendance rates and altered characteristics of sexual violence. *Acta Obstet Gynecol Scand* 2012;**91**:134–42.
5. Nesvold H, Worm AM, Vala U, Agnarsdottir G. Different Nordic facilities for victims of sexual assault: a comparative study. *Acta Obstetricia Et Gynecologica Scandinavica* 2005;**84**:177–83.
6. Hurley M, Parker H, Wells DL. The epidemiology of drug facilitated sexual assault. *J Clin Forensic Med* 2006;**13**:181–5.
7. Scott-Ham M, Burton FC. A study of blood and urine alcohol concentrations in cases of alleged drug-facilitated sexual assault in the United Kingdom over a 3-year period. *J Clin Forensic Med* 2006;**13**:107–11.
8. Scott-Ham M, Burton FC. Toxicological findings in cases of alleged drug-facilitated sexual assault in the United Kingdom over a 3-year period. *J Clin Forensic Med* 2005;**12**:175–86.
9. Hall J, Goodall EA, Moore T. Alleged drug facilitated sexual assault (DFSA) in Northern Ireland from 1999 to 2005. A study of blood alcohol levels. *J Forensic Leg Med* 2008;**15**:497–504.
10. ElSohly MA, Salamone SJ. Prevalence of drugs used in cases of alleged sexual assault. *J Anal Toxicol* 1999;**23**:141–6.
11. Hindmarch I, ElSohly M, Gambles J, Salamone S. Forensic urinalysis of drug use in cases of alleged sexual assault. *J Clin Forensic Med* 2001;**8**:197–205.
12. Slaughter L. Involvement of drugs in sexual assault. *J Reprod Med* 2000;**45**: 425–30.
13. Bosman IJ, Verschraagen M, Lusthof KJ. Toxicological findings in cases of sexual assault in the Netherlands. *J Forensic Sci* 2011;**56**:1562–8.
14. Jones AW, Kugelberg FC, Holmgren A, Ahlner J. Occurrence of ethanol and other drugs in blood and urine specimens from female victims of alleged sexual assault. *Forensic Sci Int* 2008;**181**:40–6.
15. Hagemann CT, Stene LE, Myhre AK, Ormstad K, Schei B. Impact of medico-legal findings on charge filing in cases of rape in adult women. *Acta Obstet Gynecol Scand* 2011;**90**:1218–24.
16. Stene LE, Ormstad K, Schei B. Implementation of medical examination and forensic analyses in the investigation of sexual assaults against adult women: a retrospective study of police files and medical journals. *Forensic Sci Int* 2010;**199**:79–84.
17. Creighton CD, Jones AC. Psychological profiles of adult sexual assault victims. *J Forensic Leg Med* 2012;**19**:35–9.
18. *Fakta om alkohol*. Nasjonalt folkehelseinstitutt. Available: http://www.fhi.no/artikler?id=42834; 2008 [accessed 16.10.12].
19. White C, McLean I. Adolescent complainants of sexual assault; injury patterns in virgin and non-virgin groups. *J Clin Forensic Med* 2006;**13**:172–80.
20. Astrup BS, Ravn P, Lauritsen J, Thomsen JL. Nature, frequency and duration of genital lesions after consensual sexual intercourse – implications for legal proceedings. *Forensic Sci Int* 2012;**219**:50–6.
21. Jones AW. Reference limits for urine/blood ratios of ethanol in two successive voids from drinking drivers. *J Anal Toxicol* 2002;**26**:333–9.
22. *Recommended minimum performance limits for common DFSA drugs and metabolites in urine samples*. Available: http://www.soft-tox.org/images/stories/PDF/SOFT_DFSA_Rec_Det_Limits_3-2012.pdf; 2012 [accessed 16.10.12].
23. Jones AW, Holmgren A, Ahlner J. Toxicological analysis of blood and urine samples from female victims of alleged sexual assault. *Clin Toxicology (Philadelphia, Pa)* 2012;**50**:555–61.
24. Du Mont J, Macdonald S, Rotbard N, Bainbridge D, Asllani E, Smith N, et al. Drug-facilitated sexual assault in Ontario, Canada: toxicological and DNA findings. *J Forensic Leg Med* 2010;**17**:333–8.
25. Birkler RI, Telving R, Ingemann-Hansen O, Charles AV, Johannsen M, Andreasen MF. Screening analysis for medicinal drugs and drugs of abuse in whole blood using ultra-performance liquid chromatography time-of-flight mass spectrometry (UPLC-TOF-MS) – toxicological findings in cases of alleged sexual assault. *Forensic Sci Int* 2012;**222**:154–61.
26. Bogstrand ST, Normann PT, Rossow I, Larsen M, Morland J, Ekeberg O. Prevalence of alcohol and other substances of abuse among injured patients in a Norwegian emergency department. *Drug Alcohol Depend* 2011;**117**: 132–8.
27. *Narkotikasituasjonen i Europa 2010*. Oslo: Norwegian Institute for Alcohol and Drug Research. Available: http://www.sirus.no/filestore/Import_vedlegg/rsrapport_10_fulltekst2.pdf; 2010 [accessed 16.10.12].
28. Hibell B. *The 2007 European school survey project on alcohol and other drugs (ESPAD) report, Sammendrag: Rusmiddelbruk blant skoleelever i 35 europeiske land*. Stockholm: ESPAD; 2009.
29. Vedøy TF, Skretting A. *Ungdom og rusmidler. Resultater fra spørreskjemaundersøkelser 1968–2008*. Oslo: Norwegian Institute for Alcohol and Drug Research; 2009.
30. Djezzar S, Questel F, Burin E, Dally S. Chemical submission: results of 4-year French inquiry. *Int J Leg Med* 2009;**123**:213–9.
31. Schei B, Muus KM, Moen MH. Medisinske og rettslige aspekter av voldtekt. Henvendelser til voldtektsteamet ved Regionsykehuset i Trondheim i perioden 1989–92. *Tidsskr Nor Laegeforen* 1995;**115**:30–3.
32. Haugen K, Slungard A, Schei B. Seksuelle overgrep mot kvinner – skademønster og relasjon mellom offer og overgriper. *Tidsskr Nor Laegeforen* 2005;**125**: 3424–7.
33. McGregor MJ, Lipowska M, Shah S, Du Mont J, De Siato C. An exploratory analysis of suspected drug-facilitated sexual assault seen in a hospital emergency department. *Womens Health* 2003;**37**:71–80.
34. Saint-Martin P, Bouyssy M, O'Byrne P. Analysis of 756 cases of sexual assault in tours (France): medico-legal findings and judicial outcomes. *Med Sci Law* 2007;**47**:315–24.
35. Juhascik MP, Negrusz A, Faugno D, Ledray L, Greene P, Lindner A, et al. An estimate of the proportion of drug-facilitation of sexual assault in four U.S. localities. *J Forensic Sci* 2007;**52**:1396–400.
36. Hoiseth G, Bernard JP, Stephanson N, Normann PT, Christophersen AS, Morland J, et al. Comparison between the urinary alcohol markers EtG, EtS, and GTOL/5-HIAA in a controlled drinking experiment. *Alcohol Alcohol* 2008;**43**: 187–91.
37. Moller AS, Backstrom T, Sondergaard HP, Helstrom L. Patterns of injury and reported violence depending on relationship to assailant in female Swedish sexual assault victims. *J Interpers Violence* 2012;**27**:3131–48.
38. Busch NB, Bell H, DiNitto DM, Neff JA. *A health survey of Texans: a focus on sexual assault*. Institute on Domestic Violence & Sexual Assault, The University of Texas at Austin; 2003.